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A tomographic evaluation of the tuffier line in patients with hip fracture

Tuffier's line in hip fracture

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Abstract

Aim: The aim of this study was to compare the vertebral level of the Tuffier line in patients with hip fracture with the level in a control group using computed tomography (CT) examination, and to determine whether or not the Tuffier line changed location according to age and gender. Material and Method: CT images were examined of 55 patients aged >18 years with hip fracture who presented at the Orthopaedics Clinic and of 55 patients as a control group who had lumbar CT taken for any other reason. Results: A total of 110 patients were included in the study, comprising 46 males and 64 females. The Tuffier line was determined at higher levels in the patients with hip fracture compared to the control group (p=0.006). While there was no significant relationship between gender and level in the hip fracture group (p=0.579), the Tuffier line was determined to be at lower levels in the females of the non-fracture group (p=0.000). Discussion: The results of this study showed that in hip fracture patients there could be a change according to age and gender. In particular, as the Tuffier line in hip fracture patients crosses a higher vertebral level compared to the normal population, to reduce the complication rate in the application of neuroaxial anaesthesia, it would be more appropriate to use auxiliary methods additional to the Tuffier line when determining the entry point.

Keywords

Landmark; Neuroaxial Anaesthesia; Hip Fracture

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Introduction

The application of neuroaxial anaesthesia in anaesthesia practice is often preferred in orthopaedic surgical interventions because of advantages such as low venous thromboembolism, low pulmonary embolism, early mobilisation, and less bleeding. That surgical blood loss has been reduced in orthopaedic surgical interventions in particular has been shown in meta-analyses [1]. However, because of preoperative pain in patients with fractures, there may be difficulties in the application of neuroaxial anaesthesia techniques and therefore it may not be possible to accurately determine the level at which entry is to be made in these patients. Furthermore, the level at which the procedure is applied affects the level of neuroaxial anaesthesia. One of the complications that may be seen in the application of spinal anaesthesia is spinal cord trauma. To reduce this risk to a minimum, the spinal anaesthesia entry should be made below the level of the conus-medullaris [2]. In addition to increasing the risk of spinal cord damage, applying neuroaxial block at a higher intervertebral space may cause complications such as bradycardia and severe hypotension [3,4].

The Tuffier line is the line that joins the uppermost points of both iliac crests and generally passes at the level of the L4 vertebral spinous notch or the L4-L5 intervertebral space [5]. In anaesthesia practice, this virtual line is used as an anatomic landmark, especially in the application of neuroaxial anaesthesia. The vertebral level is determined with palpation but sometimes this method may not be correct. In several studies that have confirmed the Tuffier line determined with palpation using various imaging methods, accuracy has been determined as 29%-64%. Moreover, the expected level has been shown to be above the level determined with palpation. Difference in the position of the Tuffier line is considered clinically important because the most important factor affecting the level of spinal anaesthesia is the application level of neuroaxial anaesthesia [6,7].

The aim of this study was to use CT to compare the vertebral level of the Tuffier line in patients with hip fracture with those of a control group and to determine whether or not the Tuffier line was at a normal level. The level of the Tuffier line was also compared in the hip fracture patients according to age and gender groups.

Material and Method

Participants

Approval for the study was granted by the Scientific Research Ethics Committee (approved number:05 date: 01.06.2016). The CT images were examined of patients aged over 18 years who presented at the Orthopaedics Clinic with a hip fracture between January 2012 and April 2016. Patients were excluded if they had a vertebra compression fracture, had undergone laminectomy, or had a spinal deformity such as sacralisation, lumbalisation, or scoliosis. A record was made of demographic data such as age and gender for each patient. The effect size of the study was W: 0.348 and the power of the study was 0.846 at the significance level $\alpha = 0.05$.

Radiologic Evaluation

On the CT images, to determine radiologically which vertebra level the Tuffier line crossed, the line joining the uppermost points of both iliac crests was determined by two radiology specialists. When determining the level on CT, the level of the Tuffier line was defined as passing the upper third, mid third or lower third of the vertebra corpus and it was determined at which vertebral level or intervetebral space the Tuffier line crossed (Images 1, 2). The control group comprised patients who presented at the emergency department and had lumbar CT taken for any reason other than hip fracture. Again, any of these patients with a vertebra compression fracture, or who had undergone laminectomy or had a spinal deformity such as sacralisation, lumbalisation, or scoliosis were excluded from the study.

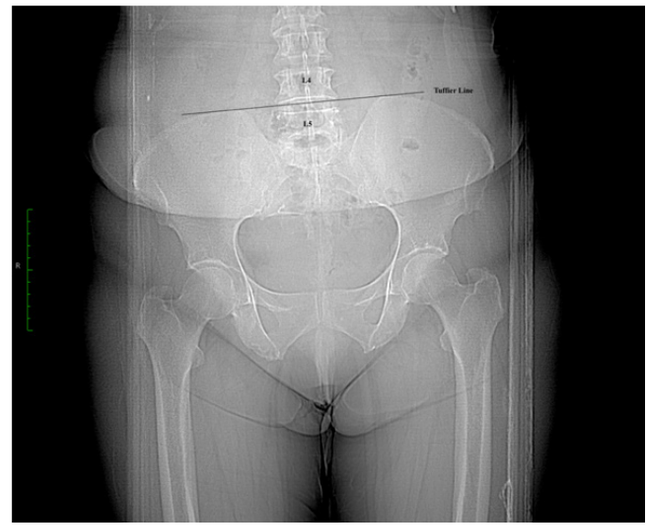

Image 1. Tuffier line crosses at the level of L4-L5 intervertebral space

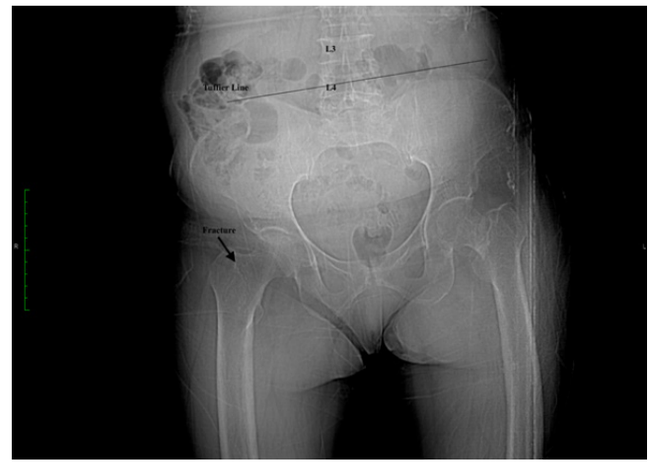

Image 2. Tuffier line crosses at the level of mid third of the L4 vertebra

Statistical Analysis

The analyses of the study data were made using SPSS 22.0 software (IBM SPSS for Windows version 22, IBM Corporation, Armonk, New York, USA). Quantitative data were stated as mean ± standard deviation (SD). Data that conformed to normal distribution were examined with the Kolmogorov-Smirnov test. In the comparison of multiple independent groups, the One Way ANOVA test was used and the Tukey HSD was applied for post hoc analysis. In the evaluation of paired independent groups, the Student's t-test was used. Differences in categorical distributions were assessed by Pearson's chi-square test and Exact test, and the power of relationship between variables was determined by Contingency Coefficient (C). The effect size of the work was specified by W (effect size). The power of the study was realized by power analysis at the significance level $\alpha = 0.05$. Data were examined at a 95% confidence interval and a value of $p<0.05$ was accepted as statistically significant.

Results

The study included a total of 110 patients comprising 46 males and 64 females. The control group, with no fracture, comprised 18 males and 37 females while the hip fracture patient group comprised 28 males and 27 females. No statistically significant difference was determined between the groups in respect of gender (p=0.054).

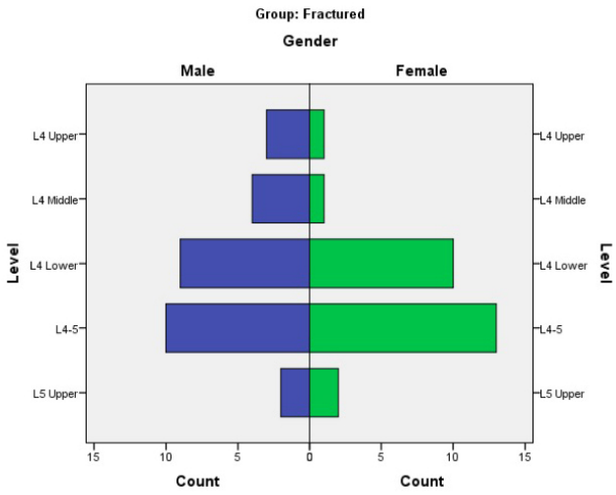

Figure 1. Tuffier line level according to gender in the fracture patient group

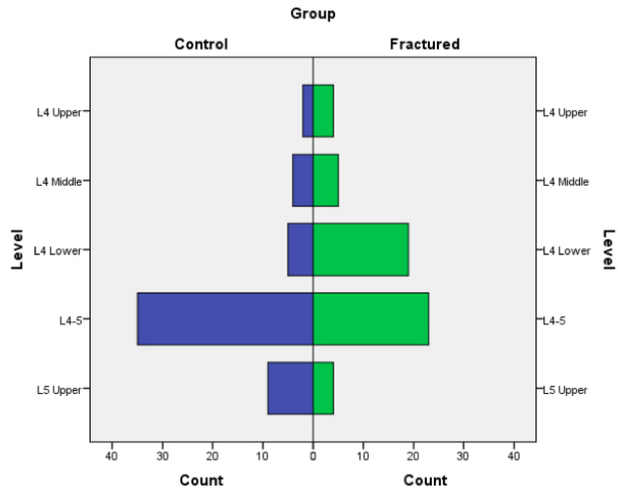

Figure 2. Tuffier line levels of both groups

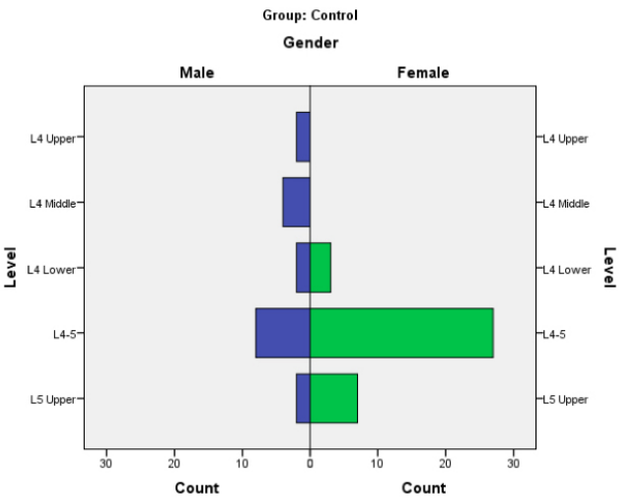

Figure 3. Tuffier line level according to gender in the control group

The mean age was 55.36±18.97 years in the control group and 62.93±21.24 years in the fracture patient group. There was no significant difference between the groups (p=0.051).

A statistically significant difference was determined between the fracture patient group and the control group with respect to the level of the location of the Tuffier line (p=0.006). According to level of the location of the Tuffier line, group sample sizes of 55 and 55 achieve 85% power to detect a difference between the null hypothesis that both group means with a significance level (alpha) of 0.05. The levels of the fracture patient group according to gender are shown in Figure 1. The Tuffier line was determined to be at a higher vertebral level in the fracture group (Figure 2). The levels in the control group according to gender are shown in Figure 3.

While there was no significant correlation between gender and level in the fracture group (p=0.454), in the control group the Tuffier line was determined at lower levels in females (p=0.001).

Discussion

The results of this study determined that the Tuffier line in patients with a hip fracture was at a higher vertebral space than in the normal population. Therefore, it is important that before the application of neuroaxial anaesthesia to hip fracture patients, these points must be given attention when determining the level at which entry is to be made, in order to reduce complications.

In this study which was conducted to evaluate the correlation between age, gender, and hip fracture and the level of the Tuffier line, the findings with respect to age and gender were determined to be consistent with the literature.

In the study, the Tuffier line in females in the control group with no fracture was determined at lower levels. In a study of 58 cadavers by Windisch et al, it was reported that the Tuffier line in females was usually at a lower level than that of males [11]. It has been reported that the Tuffier line is at a lower level in females than in males, independently of age, as the anatomic structure of the pelvic bones of females is different from that of males [12]. The wing (ala ossis ilii) section of the os ilium, which is one of the three bones forming the pelvic structure, lies more laterally in females, the iliac crests are more curved, and the pelvis major is a wider and shallower structure [14]. Due to these anatomic differences, the vertical height of the iliac bone remaining above the level of the sacroiliac joint may be less in females. Consequently, the uppermost point of the iliac crest in females may terminate at a lower vertebral level compared to males and this may cause the Tuffier line to pass at a lower vertebral level.

In a study that evaluated the lumbar MR images of 690 patients, it was reported that the conus-medullaris and the Tuffier line passed at a lower level in females than males and with increasing age, the Tuffier line passed higher [9]. Osteoporosis in elderly patients or age-related vertebral deformities leading to loss of height in the vertebra corpus result in a higher level of the Tuffier line [13,15].

Anatomically, the conus-medullaris terminates approximately at the L1-L2 level in adults. To reduce the risk of spinal cord damage to a minimum in neuroaxial anaesthesia applications, the needle entry point should be below this level. Especially in spinal anaesthesia applications, levels below the L3-L4 intervertebral space are used as the entry point.

Most studies of the Tuffier line have found a change in the accuracy and reliability of this line with age and gender, but to

the best of our knowledge there have been no studies related to specific patient groups [14-17]. In the control group with no fracture, the Tuffier line was determined in the L4 upper third segment in 5 (13.5%) patients, the L4 mid third segment in 4 (10.8%), the L4 lower third segment in 5 (13.5%), the L4-L5 space in 19 (51.3%), the L5 upper third segment in 3 (8.1%), and the L5 mid third segment in 1 (2.7%) patient. In the hip fracture patient group, the Tuffier line was determined in the L4-L5 space in 23 (41%) patients, the L4 lower third segment in 19 (33.9%), and the L4 mid segment in 6 (10.7%) patients.

In studies where the level determined by palpation has been confirmed by direct radiograph or MRI, 70-90% of the patients examined were determined with a level at the L4 spinous notch or the L4-L5 space. These were followed by the L5 spinous notch, L3-L4 space, and L5-S1 space respectively [8, 9, 10]. In the control group of the current study, the line was determined in the L4-L5 range in 51.3% of patients and in the L4 upper third segment in 13.5%, followed by the L4 mid third segment, the L5 upper third segment, and the L5 mid third segment.

In this study it was determined that the Tuffier line, which shows a difference with age and gender, and is used to determine the ideal space for the application of neuroaxial block, shifted to a higher level in patients with a hip fracture. Therefore, it is thought that correct determination of the entry point with other auxiliary methods would be able to reduce the development of complications in the application of neuroaxial anaesthesia.

Neuroaxial anaesthesia methods are the most frequently used techniques for anaesthesia in femoral fracture surgery. Difficulties in positioning these patients because of pain are particular characteristics of neuroaxial anaesthesia applications. Also pain may distort the anatomic posture and could modify the Tuffier line level. Moreover, psoas muscle spasm is an anatomical mechanism that alters the Tuffier line level. The psoas major muscle arises bilaterally from the lateral aspects of vertebral bodies, intervertebral discs, and transverse processes of the lumbar spine, converges towards the iliopubic eminence and passes along the inner side of the hip joint, insert with a common tendon on the lesser trochanter of the femur. Psoas major supports the trunk on the pelvis and prevents buckling of the vertebral column. By its attachment to the femur, it controls pelvic tilt [18].

Limitations of the study could be said to be that the evaluation of the CT images determining the level of the Tuffier line was retropective and that there was no data related to the height, weight, and body mass index (BMI) of the patients. Therefore, no evaluation could be made of the change in the Tuffier line with height, weight, and BMI.

In this study it was determined that the Tuffier line, which shows a difference with age and gender and is used to determine the ideal space for the application of neuroaxial block, shifted to a higher level in patients with a hip fracture. Especially in patients with cardiac and respiratory failures, it is even more important to determine the correct entry point. Therefore, it is thought that correct determination of the entry point with other auxiliary methods would be able to reduce the development of complications in the application of neuroaxial anaesthesia.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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